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PRACTICAL ELECTRICITY

Practical Electricity. By W. E. Ayrton, F.R.S. (London: Cassell and Co., 1887.)

PROF. AYRTON'S book on Practical Electricity fills a gap, and is well fitted for the purpose for which its author has designed it. The book comprises the substance of the first year's course for students of electrical technology in the City and Guilds Central Institution at South Kensington, with some additional matter, which is chiefly in small type. The subject of Current is treated first, then comes Electromotive Force or Potential Difference, and afterwards Resistance. This is undoubtedly the logical order, though, as Prof. Ayrton points out, this sequence appears complicated to the minds of learners, from the fact that in the definitions of the Paris Congress the volt is made to depend on the ohm and the ampere. The practical units, ampere, ohm, volt, &c., are used throughout, but a little more space might have been given with advantage to the definitions of these units. Take, for instance, the definition of an ampere,

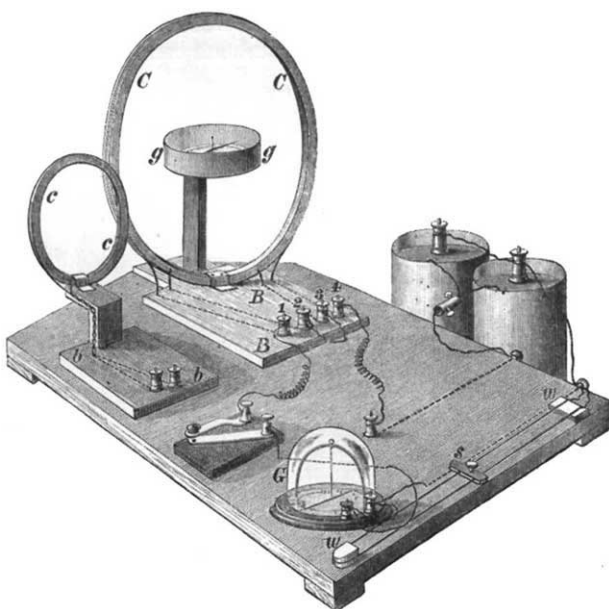
6. After showing by means of a most instructive and well-arranged experiment (Fig. 1) that a current produces magnetic, chemical, and thermal effects, and further, that the chemical changes are the same in two or more volta-meters of the same kind, Prof. Ayrton proceeds:—"We shall therefore define the strength of a current as being directly proportional to the amount of chemical decomposition produced in a given time; and the current that deposits 0.00111815 gramme or 0.017253 grain of silver per second on one of the plates of a silver voltameter, the liquid employed being a solution of silver nitrate containing from 15 to 30 per cent. of the salt, we shall call an *ampere*," and take it as our unit current." But frequently a beginner will at once wish to know why these special numbers, which will seem to him unnecessarily complex, should have been taken. Why not select .001 gramme of silver rather than 0.00111815? will be an obvious question, to which no answer is given. Surely, too, four significant figures would be sufficient. Besides, this is not the definition of ampere adopted by the Paris Congress, and it involves the experiments of someone on the electro-chemical deposition of silver. The experiments given in the early part of Chapter II. do not need the previous definition of the *unit current*, and from them the fact that a current exerts on a magnet a definite force depending on its strength and (§ 22) on the dimensions and position of its circuit is established. Thence the idea of the current which exerts on a definite magnet a unit force is easily reached, and from this we get the ampere of the Congress definition, which is found, by careful experiment, to deposit so many grammes of silver per second.

So, too, the definition of the "volt" would have been clearer if the excellent illustration of difference of potential given in § 40, Fig. 28, had been carried a little further, and it had been pointed out that, just as the water loses potential energy in falling from one level to another, and that loss is measured by the quantity of water multiplied

by the difference in pressure, so the electric current loses energy in passing from one point to another, and that loss is measured by the quantity of electricity multiplied by the difference of electrical potential. But these, perhaps, are points which can be better brought out by a teacher in explaining difficulties to his class.

The book is, we believe, the first in England which accepts distinctly the resolutions of the Paris Congress as a basis. Another novelty to be found in it is the use of the letters P.D. (potential difference) for the old abbreviation E.M.F. This is a change for which, if it can be satisfactorily introduced and accepted, all teachers will be thankful, for it will get rid of the confusion existing between the resultant electrical force at a point, and the electromotive force between two points, which is not a force at all.

The plan of the book has been already indicated. Starting from the definition of an ampere, the various means of measuring currents are described, and full



details are given of the methods for carrying out the experiments, for recording results graphically and otherwise, and for drawing conclusions from the experiments. The illustrations show clearly the arrangement of apparatus in each case. In Prof. Ayrton's laboratory the apparatus required for any one series of observations is mounted permanently on the same board; the student finds everything ready, and the necessary connexions made when he begins. As to the desirability of this, there will no doubt be some difference of opinion; but with large classes of beginners some such plan is necessary. Thus, Fig. 15 shows the apparatus for investigating the action of a current on a magnet. The large coil C C is so arranged that the current can be made to traverse it eight, twelve, or sixteen times, and its effect on the magnet g g observed; or the coil C C can be replaced by c c of half the radius, which has four turns on it; or, again, C C can be used simultaneously with c c, the current being

¹ We are indebted to Messrs. Cassell for the blocks used to illustrate this article.

sent in opposite directions through the two. ww is a resistance by means of which the current may be varied at will, and G a galvanometer.

Chapter III. introduces us to difference of potential, and here the writer describes in a practical form the experiments for the verification of some of the ordinary laws of statical electricity.

Ohm's law and its proof follow in Chapter IV., and it is shown that the resistance of a conductor remains unchanged so long as its other physical conditions are the same. § 80 gives the definition of the "legal ohm." It is not quite accurate to speak of its having been legalised, at any rate in this country; though, as the letter from the B.A. Committee on Electrical Standards, which is printed at the end of the preface, shows, the question of its adoption as a legal standard is now before the Government. Various methods of comparing resistances follow, with full practical details, but the important one due to Prof. G. C. Foster, for comparing two nearly equal resistances, has been omitted from § 97.

Batteries and other forms of current-generators are next considered, with details as to their construction and

into the zinc sulphate passing through the cork which closes the test-tube, and the whole is kept tight with marine glue.

In an appendix Kirchhoff's laws of divided circuits are considered. The method of treating such problems introduced by Maxwell, and which has recently been illustrated at some length by Prof. Fleming, is also referred to.

Another point of importance which calls for notice is the number of examples introduced by way of illustration; some of these are completely worked out, others left as exercises for the student.

The book concludes with some specimens of the instructions for experiments which are given to students at the City and Guilds Institution, with the apparatus with which each experiment is performed. Of these instructions there are four; and many who use the book will wish their number was larger. We will close this notice by quoting the last of them.

To calibrate an ammeter by means of a silver voltameter (the apparatus required has been figured above):—

"PRELIMINARY.—The voltameter consists of a platinum dish containing a 25 per cent. solution of silver nitrate, and in which a silver plate is immersed. An adjustable carbon resistance is provided, by means of which the current passing through the voltameter can be maintained constant during each experiment, and can be varied in the different experiments.

"EXPERIMENTS.—(1) Carefully clean, dry, and weigh the platinum dish, the *approximate* weight of which is 78 grammes.

"(2) Pour the solution of silver nitrate into the dish, and place it on the three brass pins provided for its reception, and which are electrically connected with the left-hand binding-screw on the board. Immerse the silver plate in the solution, and clamp it in such a position that its edges are equally distant from the sides and bottom of the dish.

"(3) Turn the small milled head at the top of the ammeter so that the pointer of the ammeter comes opposite the zero on the scale, if not there already. Place the copper connecting-wire in the mercury cups marked A and C (which cuts out the voltameter), and adjust the carbon resistance until a convenient current flows round the ammeter. Remove the connecting-wire.

"(4) Quickly insert the connecting-wire in the mercury cups marked A and B, carefully noting the instant at which the circuit was completed. Allow the current to pass for a convenient time (ten to thirty minutes, according to the strength of the current used), and keep the current constant by the adjustable resistance. Note the temperature of the room during the experiment, and, at the end of the interval decided on, quickly break the circuit.

"(5) Empty the solution from the dish into its bottle, and carefully wash the deposited silver with distilled water. Then fill the dish with distilled water, and allow it to stand ten to fifteen minutes. Again wash with water, alcohol, and ether, dry over the spirit-lamp, and cool in the desiccator.

"(6) Carefully determine the increase of weight due to the silver deposited on the dish.

"(7) Calculate the strength of current used in the experiment, assuming that one ampere deposits 1.11815 milligrammes of silver per second.

"(8) Repeat the experiment with several different strengths of current.

"(9) Tabulate your results in some convenient form, and write them with your name on the card, on which you will find recorded the results of previous experiments."

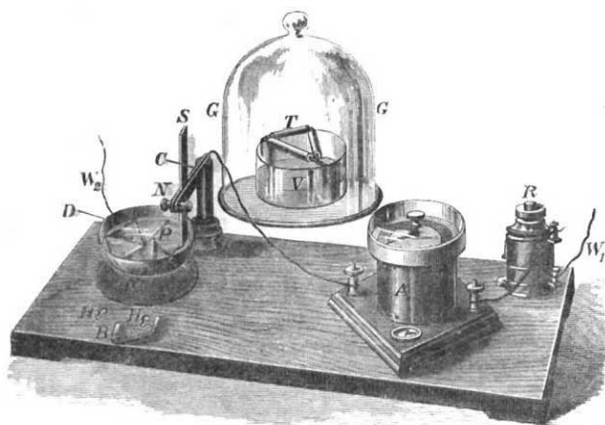


FIG. 157.

use; and an account of the methods of determining their E.M.F. and resistance is given.

"Insulation" is the title of Chapter VI., and many of the practical hints given under this head are of great value.

In the next chapter, condensers, and the methods of constructing them and of measuring their capacities, are treated of. We find also a chapter devoted to commercial ammeters and voltmeters, which gives in an easily accessible form particulars as to some of the best known of these instruments, with practical methods of testing and calibrating. In Fig. 157 we have the arrangement of apparatus for comparing an ammeter with a silver voltameter. R is an adjustable resistance of a useful character, made of a number of washers of carbonised cloth which can be pressed into close contact by a screw. Latimer Clark's cell is described in § 214, in the H form. A simpler pattern consists of a test-tube with a platinum wire sealed through the bottom. The end of this is covered with pure mercury, and above this is a layer of mercurous sulphate, with a saturated solution of sulphate of zinc above all. A rod of clean zinc dips